

CLARIFICATION PAPER

DREDGED MATERIAL VOLUME ESTIMATES

Prepared by Hiram Arden (Corps of Engineers), David Fox (Corps of Engineers) and Ted Benson (DNR) for the PSDDA agencies.

INTRODUCTION

In a PSDDA sediment sampling and analysis plan, the project proponent provides a dredged material volume estimate that is used to determine sampling and testing requirements. This volume estimate is based on bathymetric data for the site and on the dredging prism needed to meet depth requirements for navigation.

Once sampling and testing have been completed, a suitability determination for open-water disposal is signed by all four PSDDA agencies. The suitability determination identifies the portions of the estimated volume that are suitable and unsuitable for disposal at a PSDDA site. The volume suitable for open-water disposal is then incorporated into the Corps section 10/404 permit, DNR site-use authorization, and Ecology water quality certification as an upper limit on the quantity of material authorized for disposal at a PSDDA site.

PROBLEM IDENTIFICATION

Differences can occur between the permitted volume and the volume that is actually dredged. Exceedances of permitted volumes are considered violations by the regulatory agencies and can result in additional workload for the agencies and penalties for the project proponent. There are numerous factors which can contribute to exceedances of permitted volumes:

- Uncertainty in the presampling bathymetric data;
- Uncertainty from the volume estimation process;
- Shoaling that occurs between the pre-sampling survey and the time of dredging; - Failure to include overdepth material, sideslopes or "non-pay" volume;
- Uncertainty associated with barge measurements;
- Inadequate communication with agencies;
- Actual in-situ dredged volumes can only be calculated after dredging is complete.

The level of uncertainty in the bathymetric data depends on the instrumentation used, the accuracy of tide measurements, and weather conditions at the time of the survey.

Therefore, volume estimates are based on bathymetric data that include some inherent error.

There is also error associated with the various methods used to calculate volumes from the bathymetric data, including the double-end-area method and the surface-to-surface (tin) method. Double-end-area accuracy depends on the spacing of cross-sections; the greater the spacing the greater the error. The accuracy of the tin method depends upon the density of the bathymetric data. Greater density allows better contouring of the surface and less error in volume estimates.

The presampling bathymetric survey may take place long before the project is actually dredged. This time delay may range from six months to more than two years, being dependent on such factors as project complexity and resolution of habitat issues. Some additional shoaling may occur between sampling and dredging, the quantity of which depends upon local sedimentation rates, storm events and the time that has passed since the presampling survey. This additional sediment is not included in the original volume estimate and may not be reflected in the public notice or permits unless the dredging proponent has included this contingency in project planning.

A dredging project is designed to achieve required navigational depth. However, because dredging is a relatively imprecise technology, one or two feet of allowable overdepth are normally included in a dredging contract to ensure that design depths are achieved. Payment is made for the allowable overdepth actually dredged, thus providing compensation to the dredger for removing sufficient material to provide the design depth over the entire project footprint. Failure to include overdepth in volume calculations can lead to serious underestimates.

Box cuts in unconsolidated or uncohesive sediment usually result in sloughing of material to form a sideslope around the perimeter of the project. Professional judgment is required to determine the angle of repose that will result. This can be particularly difficult under piers where pilings and other structural elements can restrain sediment that would ordinarily slough. Sideslope material has been included historically in PSDDA volume estimates but overdepth for sideslopes has generally not been included. However, box cuts are often made just beyond the perimeter of the design prism so that slough material will fill the box cut without extending into the design prism. Therefore, the concept of overdepth should apply to sideslopes as well as to project depths.

Another minor contribution to dredged volume that is typically not included in estimates is "non-pay" volume. Dredging contracts are set up to compensate the dredger for any allowable overdepth that is removed. Therefore, the dredger may choose to maximize earnings by setting the dredging depth slightly below the allowable overdepth. This is usually on the order of a few tenths of a foot and although the dredger is not compensated for this small amount of "non-pay" material, this strategy maximizes the quantity of paid overdepth removed.

A practical consideration that has not been explicitly addressed in the past is the bulking of sediment that occurs due to structural disruption and entrainment of water during dredging. The amount of bulking varies with the type of sediment and the method of dredging (mechanical or hydraulic). Because of the uncertainty introduced by bulking, pay quantities in a dredging contract are most often determined by finding the difference between pre- and post-dredge surveys, rather than relying on bulked barge estimates. In contrast, daily dredging logs and progress report volumes submitted by the dredging contractor to DNR and the Corps are based on barge estimates, which can easily exceed the permitted volume due to bulking, even if the in-situ volume calculation is correct.

Because removed in-situ volumes cannot be determined until a post-dredge survey is conducted, and because bulked barge volumes can easily exceed permitted in-situ volumes, it may be difficult to determine during dredging whether permitted volumes will be exceeded. Therefore, dredgers have not always contacted DNR or the Corps when their tallied barge estimates have exceeded the calculated volume in the belief that sediment bulking alone is responsible for the increase in volume. However, given the uncertainty in both volume and bulking estimates, it is possible that the in-situ volume removed will be greater than that permitted. Failure to notify regulatory agencies in advance about a possible volume exceedance may result in a permit violation.

PROPOSED ACTION/MODIFICATION

Project proponents have generally incorporated contingencies into their sampling and analysis plans to address potential problems with volume estimates. As a result, exceedances of permitted volumes have been relatively uncommon. To further reduce the incidence of permit violations, the following guidelines are provided:

- Pre-sampling surveys should be taken as close in time as possible to the sampling event to get the best possible bathymetric data for volume estimates.
- Pre-sampling volume estimates must include allowable overdepth for the entire dredging prism, including sideslopes. Technical justification for the selected angle of repose for the sideslopes must be included in the sampling and analysis plan.
- When a box cut is proposed along a pier face, it is recommended that sloughing from under the pier be anticipated in all cases. Technical justification for the selected angle of repose for sideslopes under piers must be included in the sampling and analysis plan. The dredging proponent should ensure that all necessary geotechnical or under-pier survey data be provided to the contractor estimating the dredged material volume.
- It is highly recommended that presampling estimates of in-situ volume be increased by an uncertainty factor to account for the error inherent in the estimation process and to include reasonable "non-pay" volume. Sampling and testing requirements will be based on this adjusted volume. The uncertainty factor must be identified in the sampling and analysis plan along with a technical justification for its selection. It should be noted that

the uncertainty factor applies only to estimates of in-situ volume and is not meant to address bulking of sediments during dredging.

- The suitability determination for open-water disposal will be based on the adjusted, tested volume, as will the volume in the Corps permit, DNR authorization and Ecology certification.
- Up to two feet of additional shoaling is permitted under the PSDDA guidelines between the time of sampling and dredging without the need for additional characterization. It is the project proponent's responsibility to identify the need for a volume adjustment as a result of post-sampling shoaling. Volume adjustments should be made prior to issuing the public notice if possible. If significant shoaling occurs after the public notice has been issued, written requests for permit revisions must be made to the permitting agencies as early as possible and before dredging commences.
- An estimate of the bulking factor, and a justification for its selection, must be included in the contractor's dredging and disposal plan.
- A description of the barge measurement method must be included in the dredging and disposal plan.
- A description of the procedures to ensure vertical and horizontal dredging control must be included in the dredging and disposal plan. Such procedures prevent dredging of unreasonable non-pay volume.
- Once dredging has begun, if the dredging proponent or contractor determines that significant dredging has occurred outside the permitted dredging prism, vertical and horizontal control must be re-established immediately and DNR and the Corps contacted as soon as possible.
- When the daily barge estimates, corrected for bulking, tally to fifty percent of the permitted in-situ volume, the dredging contractor must confer with the Corps, DNR and the dredging proponent. Based on the experience of the dredging contractor during the first half of the project a correction in the bulking factor will be made if necessary. Dredging progress (based on condition surveys or spatial coverage) will then be compared to the corrected barge measurements (using the revised bulking factor) as a check on the adequacy of the permitted in-situ volume. A decision will be made by the conferees as to whether permit revisions for an increased volume will be necessary. Details of this coordination procedure must be included in the dredging and disposal plan.
- As dredging proceeds, the contractor must closely monitor dredging progress and notify the agencies as soon as possible if an exceedance of the permitted volume appears likely. Revision of the permits will be made as necessary. Dredging must stop when the sum of the daily barge estimates, corrected for bulking using the revised bulking factor, reaches the permitted in-situ volume. DNR and the Corps must be notified at this time. If the dredging has not been completed, a determination will be made as to the cause of the

impending volume exceedance and permit volumes revised as appropriate. It must be stressed that, given the contingencies incorporated into the above process, the probability of a dredging contractor being required to stop dredging is small. Good project management and prompt communication with the regulatory agencies will prevent this from occurring.

- Post-dredge surveys will be reviewed by the agencies, as necessary, to ensure that the dredging plan has been followed.

No penalties will be imposed by the PSDDA agencies and any quantity beyond the permitted volume will be charged by DNR at the standard rate (currently \$0.45 per cubic yard) if: 1) the process outlined in this paper is followed; 2) no unreasonable dredging has occurred outside the permitted dredge prism; and 3) all other permit conditions have been met.

NOTE: The Swinish Channel and the settling basins in the Duwamish and Snohomish Rivers are prone to rapid shoaling. Pay quantities are frequently determined from barge measurements and not all of the above guidance will apply to these projects. Also, in cases where contaminated sediment is adjacent to sediment that is being dredged for open-water disposal, more stringent dredging controls must be instituted to ensure that unsuitable material is not dredged and disposed at a PSDDA site. Damages resulting from dredging and disposal of unsuitable material are not addressed by this clarification paper.